Vosburg 1922

U. S. DEPARTMENT OF AGRICULTURE
FARMERS BULLETIN No. 1343

CULTURE OF CITRUS FRUITS

IN THE GULF STATES

IMPERIAL MYCOLOGICAL INSTITUTE
8 NOV. 1938

UNITED STATES DEPARTMENT OF AGRICULTURE
1862 1889

THIS BULLETIN discusses the business of growing citrus fruits for the market from the standpoint of the prospective grove owner, at the same time summarizing for the experienced grower the results of recent investigations on pest control and grove management. Emphasis has been laid on the choice of sites and soils with reference to frost protection, variety and stock adaptation, cultural methods, and economy in production.

The prospective grower of citrus fruits is advised that personal investigation on the ground in advance of investment is always economical and may avert serious loss and disappointment, since areas quite worthless for citrus growing may lie adjacent to some of the best citrus developments.

The growing of citrus fruits of such excellence as to command a ready market is a highly complex business. Skill, energy, and attention to details are requisites for the successful grower, whether a beginner or one already having some experience in citriculture.

Washington, D. C. July, 1923

CULTURE OF CITRUS FRUITS IN THE GULF STATES.[1]

By E. D. Vosbury, *formerly Scientific Assistant, Office of Horticultural and Pomological Investigations, and* T. Ralph Robinson, *Crop Physiologist, Office of Crop Physiology and Breeding Investigations, Bureau of Plant Industry.*

CONTENTS.

	Page.		Page.
Scope of the work	1	Varieties of citrus fruits for the Gulf States	11
History of the Florida citrus industry	1	Propagation of citrus trees	16
History of the citrus industry in the other Gulf States	3	Grove management	19
Selection of a locality and site for a grove	5	Harvesting and marketing citrus fruits	37
Kinds of citrus fruits for the Gulf States	8	Cost and profits in citrus growing	38
		Publications on citrus fruits	40

SCOPE OF THE WORK.

THERE is an increasing demand, especially on the part of newcomers and prospective growers, for information concerning citrus-fruit growing in the Gulf States. While it is not feasible in this bulletin to give complete information regarding such a complex industry as modern citrus culture, it will be of value to outline some of the general principles as a guide to those interested.

As Florida produces by far the most citrus fruits of all the States under consideration, a more complete discussion is given of the industry in that State than for the other sections. Much of the information relative to Florida, however, will be applicable to the other Gulf States as well. Whenever marked differences in methods exist, each locality is considered separately.

HISTORY OF THE FLORIDA CITRUS INDUSTRY.

Oranges, grapefruit, and other citrus fruits were first brought to the United States by the Spaniards, who planted them in Florida more than three centuries ago. Prior to 1870 the commercial citrus crop of Florida was limited to the output of a few small groves in the northern part of the State. Most of the groves were situated along the banks of the St. Johns and other rivers, as practically the sole means of transportation was by river boats. The methods of culture, harvesting, and shipping were very crude, but in spite of

[1] This publication is a revision of and supersedes Farmers' Bulletin 1122, Citrus-Fruit Growing in the Gulf States.

many handicaps the pioneer growers prospered, and after the advent of the railroad lines in the early sixties the industry grew very rapidly. Most of these early plantings were of orange trees. Grapefruit culture was neglected, and the fruit had little market value until the late eighties, when it began to grow very rapidly in favor, until at the present time the grapefruit is becoming a close rival to the orange in commercial importance.

The first severe freeze recorded was in 1835, when orange trees from 40 to 50 years old were killed at St. Augustine and Mandarin. No freeze since that time has been so severe.

The second serious check to the growth of the industry occurred in 1886, when a severe freeze ruined most of the orange crop and killed many young trees. In the winter of 1894–95 [2] two disastrous freezes killed most of the trees to the ground and ruined thousands of groves. In 1899 another killing freeze occurred. As a result of these costly experiences much of the old northern citrus area was abandoned permanently and the industry was relocated in southern and central Florida. From that date citrus production in Florida increased without any serious check until 1917, when a freeze in February in many sections killed to the ground most of the young trees, frosted most of the crop remaining on the trees at the time, and in some sections cut back the bearing trees severely.

Although the citrus industry has fully recovered from these disasters, the various freezes have taught the growers many valuable though costly lessons. The importance of selecting grove sites which are relatively free from frosts has been strongly emphasized, and the advisability of protecting groves by some means of orchard heating has been demonstrated, particularly in those sections where killing frosts have been experienced. The importance of crop diversity has also been recognized, and many growers who formerly produced citrus fruits exclusively are now raising livestock, truck, forage crops, and other staple farm produce in sections where soil conditions permit.

One-crop farming at best is a gamble, and in case of a severe freeze the man with a number of staple farm crops is much better prepared to weather the lean years than the grower who has oranges only. Furthermore, in diversified farming the labor, horses, and equipment are more efficiently and economically employed through the year than where nothing but a citrus crop is produced. Exception may be noted in the case of citrus regions particularly well located for frost protection and where soil conditions, as in the sandy-ridge section of Florida, are not favorable to crop diversity.

As a result of these experiences the Florida citrus industry is now on a more stable basis than at any time in the past. Great improvements have been made in cultural methods and in the control of insects and diseases. The introduction of modern methods of harvesting, packing, and shipping has stimulated both production and demand by enabling the fruit to be shipped to the most distant markets with a minimum loss from decay.

---

[2] Webber, H. J. The two freezes of 1894–95 in Florida, and what they teach. U. S. Dept. Agr. Yearbook, 1895, pp. 159–174, figs. 16–22, pl. 3. 1896.

Four distinct citrus-growing sections of Florida have been outlined,[3] as follows:

Northwestern Florida, that part of the State lying west of the Aucilla River; eastern Florida, that part between the Aucilla River and a straight line drawn from the mouth of the St. Johns River to Cedar Keys; central Florida, that part of the State between the line referred to above and north of the counties constituting southern Florida; southern Florida, the counties of Brevard, Dade, Monroe, Lee, De Soto, Manatee, St. Lucie, and Palm Beach.

By far the greater portion of the citrus fruits are produced in the central and southern sections of Florida. In the western and eastern sections of northern Florida the citrus industry is of relatively minor importance, although there are a number of small, isolated groves, and in the northwestern part of the State plantings of Satsuma oranges have been made in the last few years.

One of the most important factors in raising the standard of citrus growing in Florida has been the Florida Citrus Exchange, a nonprofit, cooperative marketing organization which includes growers in all parts of the State. The Florida State Horticultural Society has also been a valuable agency in promoting the social and business relations of the citrus growers.

HISTORY OF THE CITRUS INDUSTRY IN THE OTHER GULF STATES.

In a narrow area on either side of the Mississippi River south of New Orleans, in Louisiana, citrus fruits have been grown for many years. This region has experienced occasional setbacks from frosts and other causes, but citrus fruits are still grown there commercially on a small scale. Most of the crop is sold in the New Orleans market.

Extensive plantings of Satsuma oranges and other citrus fruits have been made in other sections of southern Louisiana. The losses from killing frosts have been so heavy, however, that most of these plantings have been abandoned. Many experienced Louisiana growers believe that citrus planting, except in the region south of New Orleans, should be restricted to small groves in the most frost-free localities. A number of such small groves of Satsuma oranges have been found profitable in the production of fruit for the local markets. Usually these groves consist of an acre or two of fruit, planted on protected sites on southern Louisiana farms where general farming is practiced.

The commercial planting of citrus fruits in Texas is now restricted almost entirely to the lower Rio Grande Valley, where several thousand acres are planted under irrigation, water being pumped from the Rio Grande River. Grapefruit constitutes about three-fourths of the present acreage, the remainder being about equally divided between oranges and lemons. Commercial shipments on a car-lot basis were commenced in 1921–22, and the distribution thus far has been limited to near-by cities.

---

[3] Catalogue of fruits. *In* Proc. 18th Ann. Meeting, Fla. State Hort. Soc., 1905, pp. i–xxii. 1905.

Considerable loss has been experienced in the past from the freezing of young trees, and some form of frost protection is considered necessary. Owing to the tendency for seepage water from irrigation canals to accumulate in low spots with consequent water-logging and rise of alkali, many plantings on undrained locations have suffered. The acreage already planted is ample to determine in due time whether this section of Texas is suitable for commercial citrus culture. Furthermore, until storage systems for irrigation are developed to safeguard both the quantity and quality of the water available, it would seem hazardous to extend citrus plantings further, particularly as the acreage of orchard crops can not be regulated to accommodate the supply of water, as with ordinary field crops. Citrus fruits should be grown as one crop in a scheme of general or diversified farming rather than as a single-crop venture.

Satsuma oranges and other citrus fruits were at one time extensively planted along the northern Gulf coast section of Texas, particularly in the vicinity of Houston and Beaumont. Many of these plantings were repeatedly killed back by cold, and in the winter of 1916–17 thousands of acres of citrus groves were frozen to the ground and abandoned. On account of unfavorable climatic conditions and other factors, as pointed out by the United States Department of Agriculture in past reports,[4] the Gulf coast of Texas is not in general a promising section for the profitable and conservative development of an extensive citrus industry. Future plantings north of the Rio Grande Valley should be limited to small groves of the hardier sorts of citrus fruits, such as Satsuma oranges and tangerines, planted in the most favorable localities to produce fruit for the home or local markets.

In Alabama the main citrus sections are located in Mobile and Baldwin Counties. In Mississippi there are smaller commercial plantings along the Gulf coast. These plantings consist almost entirely of Satsuma orange trees, although a few round oranges and grapefruit are grown for home use. The industry in this section received a severe check in the heavy freezes of the winter of 1916–17, when hundreds of acres of groves were cut back or killed. As a result of this freeze and a number of previous freezes, Mississippi and Alabama growers have come to the same conclusion as the Florida growers, namely, that groves should be located on the most frost-free sites, and for the greatest degree of safety the grower here, as in most other localities, should make citrus culture a part of general farming rather than a single-crop venture.

These setbacks and their lessons to the growers have placed the Satsuma orange industry in Alabama and Mississippi on a much safer basis than in earlier years. A cooperative association of the growers, known as the Gulf Coast Citrus Exchange, has been of much assistance in the development of the marketing end of the industry in that section. The Gulf Coast Horticultural Society fills the same place with reference to the citrus industry in northwestern Florida, southern Alabama, and southern Mississippi as does the Florida State Horticultural Society for the main citrus sections of Florida.

[4] Agricultural conditions in southern Texas. U. S. Dept. Agr., Bur. Plant Indus. [Misc. Pub.] 457, 8 pp. 1909.

Small home orchards, including the Satsuma and round oranges and occasionally a few lemon and grapefruit trees, are found in many Gulf State sections too cold for larger commercial plantings. A few very small groves have been planted in southern Georgia and on the islands off the coasts of Georgia and South Carolina. In these colder sections citrus plantings are confined to trees budded on trifoliate-orange stock and grown in sheltered dooryards and similar spots where they can be protected in winter.

The principal areas within which citrus fruits are grown are shown in Figure 1.

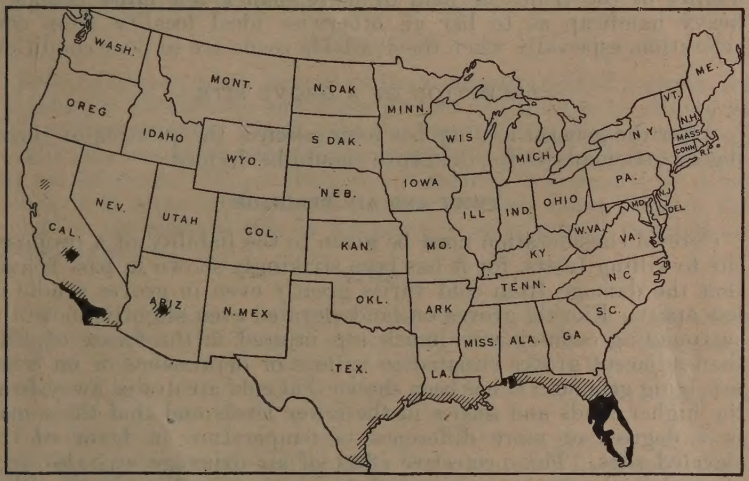

FIG. 1.—Outline map of the United States, showing the principal regions in which citrus fruits are grown commercially. The shaded areas show the regions where citrus fruits are grown. The heavily shaded areas show important commercial citrus sections.

SELECTION OF A LOCALITY AND SITE FOR A GROVE.

CHOOSING A GENERAL LOCALITY.

The first problem to be solved by the prospective citrus grower is the selection of a general locality and a particular site in that locality for planting the grove. It is quite impossible to answer the questions so frequently asked regarding the advantages of one locality compared with another. Each section has its particular advantages and drawbacks, and one investor will prefer conditions to which another would strongly object. Prospective growers should therefore make as thorough and careful an investigation as possible, especially when the amount of capital available is limited. The various State agricultural experiment stations will gladly advise prospective settlers as to sites, and in many cases they can put newcomers in touch with experienced, successful citrus growers from whom valuable information can be secured. It is inadvisable to purchase lands for agricultural purposes without first making a careful personal investigation of the locality, especially when such a large investment is involved as is necessary in the development of a citrus grove.

The general advantages of any locality for a farm home, including sanitary conditions, nearness to good schools, neighbors, roads, and other factors, should be fully considered. Due emphasis should be placed on the record of any locality as to damage from killing frosts in the past. In general, growers should restrict extensive plantings to established and prosperous communities which have a long record for the extensive and profitable production of high-quality fruit.

It is a great advantage to be located near a shipping point and close to a packing house with a high reputation for the quality of its output. Long wagon hauls are expensive and impair the shipping quality of the fruit. A haul of more than a few miles is such a heavy handicap as to bar an otherwise ideal locality from consideration, especially when the available roads are in poor condition.

SELECTION OF A GROVE SITE.

After the general locality has been selected, the question of choosing a particular site for the grove should be decided.

FROST AND AIR DRAINAGE.

Careful consideration must be given to the liability of a proposed site to killing frosts, for it has been strikingly shown in past freezes that the damage from cold varies greatly even in groves a mile or less apart. Florida groves on land elevated even slightly above the surrounding country were much less injured in the freeze of 1917 than adjacent groves situated in valleys or depressions or on other low-lying ground. It has been shown that cold air drains away from the higher lands and settles in the lower levels and that there may be 5 degrees or more difference in temperature in favor of the elevated sites. This protective effect of air drianage was also very marked in the orange sections of Alabama, as well as in the other Gulf States, following the freezes of the winter of 1916–17.[5] Groves on low lands and in depressions generally were badly frozen back, while those on higher lands in the immediate vicinity escaped with much less injury. One of the Alabama growers remarked that the freezes had had one benefit, "They have shown us where not to plant."

SOIL DRAINAGE.

Land slightly elevated has another great advantage over low land and hollows, aside from that of greater freedom from frost, namely, that of better soil drainage. Good soil drainage is an essential factor, and land subject to overflow or land where the water table stands less than 3 or 4 feet from the surface at any season of the year should be avoided unless this defect can be remedied by artificial drainage.

FROST PROTECTION AFFORDED BY BODIES OF WATER.

Lakes, bays, and other bodies of water may afford valuable protection from frost, particularly when they are of considerable size.

[5] Winberg, O. F. E., Starcher, G. C., and Isbell, C. L. Report on freeze injury to citrus trees for 1916 and 1917, with notes on orange culture in south Alabama. Ala. Agr. Expt. Sta. Bul. 199, 26 pp., 7 pl. 1918.

This protective influence of water, however, is limited almost entirely to groves on the leeward side of the water bodies and is seldom noticeable for a distance of more than a mile or so from the shore. In the freeze of 1917 groves on the southern shore of Lake Apopka, Fla., a circular body of water about 25 miles in diameter, suffered very little injury, although groves 2 miles farther south were severely cut back. In this instance the freezing winds came from the northwest, and only the groves on the south and southeastern, or leeward, shores received noticeable protection. In the case of very large bodies of water, such as the Gulf of Mexico, the protection afforded is much more extensive.

WINDBREAKS.

Belts of timber, when located on the windward side of a grove, are valuable as windbreaks and often protect the trees from drying as well as from freezing winds. On the leeward side of the grove such windbreaks are of no value and may actually be a detriment, checking air drainage. Where the grove is entirely surrounded by dense woods it is often advisable to cut one or more lanes through the woods on the leeward side of the grove so as to permit the cold air to drain away.

SOILS.

Although citrus trees will grow in many soils, they are much better adapted to some soils than to others, and the selection of the proper kind of soil should be carefully considered. In Florida the soil types used most extensively for citrus groves are known as high pine, flatwoods, high hammock, and low hammock.

Low-hammock soils in their virgin state support a luxuriant growth of cabbage palmettos, oaks, bays, or other hardwood trees. They are the richest of the four soil types in fertility and humus, and while expensive to clear they make splendid citrus soils if well drained.

High-hammock lands have a higher elevation and a more open growth of hardwood trees than low-hammock lands. They are fertile and well drained, and many growers consider them the most desirable of all citrus soils. In general, these hammock soils require much less fertilizer than the lighter pineland soils.

Most of the recent citrus plantings in Florida have been made on high pineland, three grades of which are recognized. The best grade is characterized by large straight-growing pines with occasional oaks, hickories, or other hardwood trees. The soil is a sandy loam, fairly rich in humus, and is underlain with a clay subsoil at a depth of 6 feet or less. In second-grade pinelands the pine trees are smaller and there are few or no hardwoods, while the subsoil is farther from the surface. In the third or poorer grade the pines are still smaller and scrubbier and the clay subsoil far below the surface soil.

The high pinelands as a class are well drained and relatively inexpensive to clear. The better grades, while not high in fertility, make good citrus lands if the humus supply is adequately maintained.

Flatwoods pineland is usually low and uniform in elevation. The soil is often rich in humus, and where such land can be adequately

drained it may be well adapted to citrus culture. Many flatwoods areas, however, are poorly drained or subject to overflow. Frequently they are underlain with a layer of hardpan. Such soils are of very inferior value for citrus trees and should be avoided. A dense growth of saw palmettos in pine flatwoods is frequently an indication of an undesirable hardpan or subsoil.

The several soil types described for Florida are also found in some of the other Gulf States. In Louisiana, south of New Orleans, the soil is of a rich alluvial character and is frequently subject to overflow from the Mississippi River, so that high dikes are often necessary to keep the water from injuring the groves.

In the Rio Grande Valley of Texas the soils are of a silty formation. In southern Alabama and Mississippi well-drained hammock lands and the more fertile type of pinelands are preferred for citrus plantings. The best types contain considerable humus and have a clay subsoil within 2 or 3 feet of the surface.

KINDS OF CITRUS FRUITS FOR THE GULF STATES.

RELATIVE IMPORTANCE OF THE CITRUS FRUITS GROWN.

After the locality and site have been selected the next problem is that of choosing the best kinds and varieties of citrus trees for planting. The most important citrus fruit grown in Florida is the common round sweet orange, which is produced in all the citrus sections of the State. Round oranges are also grown commercially in the Delta region of New Orleans.

Grapefruit ranks next to the round orange in importance (fig. 2). The trees are less hardy than the orange, and extensive plantings are found only in central and southern Florida, although there are a few grapefruit groves in the orange sections of Louisiana and Texas and scattered trees in the other Gulf State citrus sections.

The Satsuma orange and the tangerine rank next to grapefruit in importance. Satsuma oranges are the most important of the citrus fruits grown in northwestern Florida, southern Mississippi, southern Alabama, and other sections too cold for round oranges and grapefruit. Although the Satsuma orange when budded on trifoliate stock is considerably hardier than the round orange, it is by no means "frost proof," and it should be planted only on the more frost-free sites of the sections where it has already proved successful. In southern Florida the Satsuma orange is of unsatisfactory quality and is seldom planted. The tangerine is grown most extensively in southern and central Florida, but it is also raised in all the citrus sections of the Gulf States. It is almost or quite as hardy as the Satsuma orange when grown on the same stock.

Lemons are much more tender than oranges and should be planted commercially only in the warmest sections. Prior to the great freeze of 1895, which killed most of the trees, many thousands of boxes of lemons were shipped from Florida, but now there are no large commercial lemon groves in the Gulf States, although numerous lemon trees are grown in dooryards throughout southern Florida. It is possible that lemon culture could be extended in the most protected

regions of extreme southern Florida, such as the coastal regions south of Fort Pierce and Punta Gorda, to the point of producing sufficient fruit for the local markets.

Limes are still more tender than lemons, and their commercial culture is restricted to the Florida keys and to a few of the best-protected localities of southern Florida. For home use limes are often grown in sheltered dooryards much farther north. The demand for limes is much greater than the supply, and their culture in favorable localities of southern Florida, such as on the keys and in the coastal regions mentioned, promises good returns.

The kumquat is a small tree or bush which bears abundant round or egg-shaped fruit the size of small plums. It is hardy, makes a handsome ornamental, and is popular as a dooryard shrub in all the Gulf coast sections. The fruit is grown to a small extent commercially and shipped to the North as fancy fruit for the holiday trade. In the vicinity of Mobile and in a few other sections kumquats are grown for marmalade and other preserves.

Citrons, shaddocks, and a number of other citrus fruits are occasionally grown as ornamentals in Florida and the Gulf coast sections.

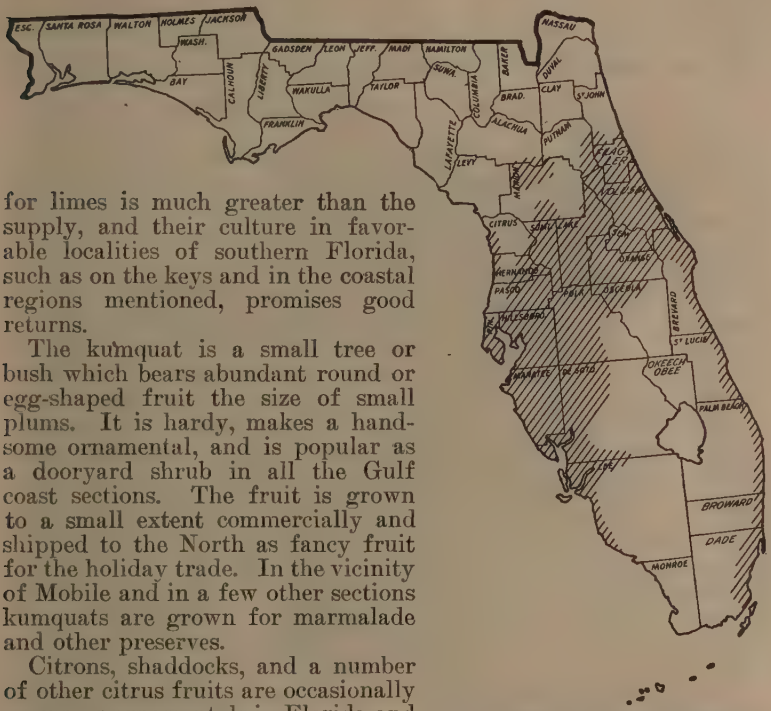

FIG. 2.—Map of Florida, showing, by shading, the location of the principal regions within which round oranges and grapefruit are grown.

Tables 1 and 2 from the United States census report for 1920 show the relative importance of the citrus fruits grown in the Gulf Coast States in 1919.

TABLE 1.—*Principal citrus fruits grown in Florida, 1919.*

Fruit.	Bearing trees.	Nonbearing trees.	Boxes.	Value.
Orange	3,645,811	2,311,571	5,930,422	$15,715,618
Grapefruit	1,681,481	963,336	3,158,431	6,158,941
Limes	115,624	80,870	27,725	97,040
Tangerines	38,516	29,770	67,475	236,170
Lemons	34,176	22,756	31,204	93,612

TABLE 2.—*Citrus fruit trees (bearing and nonbearing) in Alabama, Mississippi, Louisiana, and Texas, 1919.*

Fruit.	Alabama.		Mississippi.		Louisiana.		Texas.	
	Bearing trees.	Nonbearing trees.	Bearing trees.	Nonbearing trees.	Bearing trees.	Nonbearing trees.	Bearing trees.	Nonbearing trees.
Orange	[1] 260,294	[1] 165,536	[1] 28,127	[1] 37,350	104,382	26,356	14,331	41,329
Grapefruit	587	1,337	571	944	405	727	5,454	74,039
Miscellaneous	[2] 2,969	[2] 469	.....	.....	.....	.....	[3] 1,385	[3] 8,383

[1] Principally Satsuma oranges. [2] Tangerines, kumquats, lemons, and limes. [3] Principally lemons.

IMPORTANCE OF STANDARD VARIETIES.

The early citrus groves in Florida, Louisiana, and other Gulf States consisted almost entirely of seedling trees. Many of these old seedling groves still remain, but they are fast disappearing. Seedlings are no longer planted in Florida, although they are quite frequently set in some of the other citrus sections.

In the early days of citrus growing in Florida there were one or more seedling orange trees in each community locally famous for superior fruit. Budwood was taken from such trees and a large number of varieties were thus named and planted. Largely as a result of the great number of varieties grown, the citrus output of Florida has been much less uniform in appearance and quality than that of California, where but two varieties of oranges—the Washington Navel and the Valencia—are extensively grown. It has long been recognized in Florida that of the many varieties available a few should be chosen which can be developed as typical standard commercial sorts and the other less desirable ones eliminated.

As a result of this demand for standardization, a committee of prominent growers and nurserymen was appointed by the 1916 Citrus Seminar at Gainesville, Fla., to recommend a short list of selected varieties. The orange varieties chosen as standard were the Parson (*Parson Brown*), Homosassa, Valencia, Pineapple, and Lue (*Lue Gim Gong*). No action was taken for grapefruit.

In making up his planting list the grower should limit his choice to two or three of the standard varieties of oranges best suited to his special requirements of soil, season, and situation. For each locality there are certain varieties which are best adapted. The Parson orange, for example, matures earlier and colors up more fully in the hammock sections of north-central Florida than in localities farther south. The Valencia variety, on the other hand, is less desirable for northern Florida, as, on account of its late season of ripening, crops are frequently lost by frosts. The grower should take into careful consideration the matter of varietal adaptability before making out his planting list. The same course should be taken with grapefruit, although there is less varietal distinction with grapefruit than with oranges.

In southern and central Florida many experienced growers diversify their citrus plantings and are setting out two or three standard varieties of oranges, three or four of grapefruit, and one of tangerines. A few growers are planting oranges or grapefruit, or

even tangerines, exclusively, but it is believed that the practice of growing some of each kind will be the safest and most profitable in the long run. In the colder citrus sections there is less opportunity for such diversity, as the choice must be limited to the hardier sorts and those maturing early.

HOME-GROWN VARIETIES.

Every home in the citrus region of the Gulf States should have its own supply of fruit from a small grove or dooryard planting. With a little care the trees can be made to give returns in pleasure and in good fruit far exceeding their cost.

For the home orchard a much wider choice of varieties is possible and desirable than for the commercial grove. The ideal to work for in planning the home planting is a succession of high-quality fruit throughout as long a season as possible. Very often fruits too tender for commercial planting in the locality can be successfully grown in the dooryard by giving them some winter protection.

VARIETIES OF CITRUS FRUITS FOR THE GULF STATES.

VARIETIES OF ROUND ORANGES.

The Parson (*Parson Brown*) is the earliest commercial variety grown in Florida. Its season is from early October to November, and the fruit is often sweet enough to ship while the skin still shows considerable green color. The fruit is medium in size and oblong in form, with a fine-textured peel. The dessert quality is fair to good when grown under the most favorable conditions. It does best when grown on sour-orange stock in hammock soil, while on rough-lemon stock, when planted in light soil, it is usually dry and poor. Many growers in northern Florida and in other colder citrus sections plant the Parson because it matures before the season of dangerous frosts. Early fruit of other varieties is often shipped and labeled "Parson Brown," but this practice is discredited by all reputable growers. The Parson, while not an ideal sort, is the best known and most widely planted early variety.

The Homosassa variety matures from late November to February. The fruit is round, somewhat flattened, and medium to large in size. The appearance, dessert quality, and shipping quality are excellent. The trees are regular and prolific bearers when given good care. Those who have grown the Homosassa consider it a profitable variety, and it will doubtless be more widely planted in the future, as it replaces in season the old seedling trees now rapidly dying out.

The Pineapple is the leading midseason variety, maturing from late December to early March. It is variable in shape, medium to large in size, with a thin glossy skin of high color and has numerous seeds. It is a good shipper and has high dessert quality when well grown. The tree is prolific and vigorous. The fruit often has a distinct pineapple aroma when mature, from which characteristic the name was doubtless derived. (Fig. 3.)

The Valencia, formerly known in Florida as "Hart's Late" and also as "Tardiff," is the latest standard variety grown. The fruit

is slightly oval in shape, of good size, and has a very smooth, tough peel. It ripens in March and April, frequently hanging on the trees late into May.

The Lue (*Lue Gim Gong*) is a late variety of recent origin. It is very similar to the Valencia in size, shape, and other characteristics, but it is claimed that the fruit will hang on the trees even later than that variety. The Lue has been planted rather heavily in Florida during recent years, but is generally marketed as a Valencia.

In addition to the standard varieties mentioned, several other oranges are frequently grown in Florida. The various blood varieties, including the Ruby, Maltese, and St. Michael, are often grown commercially. Although somewhat lacking in vigor, the blood oranges are frequently profitable when grown on fairly strong soils. They

FIG. 3.—Grove of oranges of the Pineapple variety at Dunedin, Fla.

are of highest dessert quality and usually bring a premium over other varieties when shipped as fancy fruit. They are especially recommended for home plantings.

Several other old varieties, such as Jaffa, Enterprise (seedless), Drake Star, and Lamb Summer, are grown in certain localities to which they seem especially adapted.

In Louisiana much of the orange crop is picked from seedling trees and shipped as "Louisiana Sweets" or "Creole" oranges. While much of this seedling crop is of high dessert quality, most Louisiana growers now believe that a more uniform and profitable crop can be secured by substituting standard varieties for these miscellaneous sorts. Consequently, recent plantings in Louisiana are largely of the standard Florida varieties, such as the Pineapple and the Parson. Washington Navel oranges on trifoliate-orange stock are grown profitably by some citrus growers in the lower Mississippi Delta section.

In the lower Rio Grande Valley of Texas the more common varieties are the Parson, Washington Navel, Pineapple, and Valencia. The Parson has been locally named "Texas Sugar" and seems well adapted to the Rio Grande sections. The Dancy tangerine and King orange are also finding some favor because of earliness and high color. The Washington Navel is only fairly productive and yields fruit of too large a size to meet trade requirements. In southern Mississippi and Alabama very few round oranges are now planted commercially.

GRAPEFRUIT VARIETIES.

Most grapefruit varieties are less distinct in their characteristics than oranges. A large part of the Florida crop is produced on budded trees of unnamed local sorts. This fruit, together with the product of seedling trees, is popularly designated as "Florida common." The more recent plantings, however, are largely confined to the standard named sorts.

The Hall is a midseason variety maturing in February and March. The dessert quality is good and the trees are prolific. The fruit is frequently borne in clusters, and the variety is often known as Silver Cluster.

The Walters is also a midseason variety which is picked in February and March, and sometimes later. The dessert quality is excellent, although it is sometimes objectionably seedy. The trees are vigorous and prolific. The Walters variety is very similar to the Hall, and they are frequently regarded as identical.

The Marsh (*Marsh Seedless*) variety matures at the same season as the Walters. The dessert quality is good, although the fruit lacks somewhat the characteristic bitter principle of most grapefruit. The fruit is seedless, or nearly so, and this quality is considered of much value.

The Duncan is the standard late-season variety. It matures in Florida from April to May and can sometimes be left on the trees until early June. The dessert quality is excellent, and the trees are vigorous growers, good bearers, and somewhat hardier than other grapefruit varieties.

The McCarthy is another late variety of good dessert quality. The trees are vigorous and prolific. The fruit is borne singly rather than in clusters, as is the case with most other grapefruit varieties.

The Davis (*Davis Seedless*) is a seedless variety which has been quite extensively planted in Dade County, Fla., during the last few years. It has not yet been fully tested, but is considered a promising variety for trial.

The Triumph is one of the earliest of grapefruit varieties, frequently maturing in December. On account of its extreme seediness and small size, however, it can not be recommended for commercial planting, although it is worthy of a place in the home grove.

The Foster, a pink-fleshed variety originating as a bud sport of the Walters, is finding some favor because of its unusual color and early maturity.

In the citrus sections of the Gulf States, aside from those in Florida, the favorite grapefruit varieties are the Duncan, Marsh,

Walters, and Foster. The Duncan is well adapted for the colder sections where grapefruit is grown, as the tree is somewhat hardier than the other standard sorts.

VARIETIES OF KID-GLOVE ORANGES.

Because of the ease with which the skin may be separated from the pulp, the tangerine, the Satsuma, and the mandarin are popularly known as kid-glove oranges.

The Satsuma was formerly considered a single distinct variety, but recent investigations indicate that at least six varieties are grown in Japan.[6] Two of these varieties, the Owari and Ikeda, appear to have been introduced into the United States at an early date, and most of the commercial plantings can be referred to one of these two varieties. The Owari is a flat thin-skinned fruit of good quality, maturing early. The Ikeda is inclined to be more spherical in shape, the skin is thicker and coarser in texture, and the season is usually from two to four weeks later than the Owari. For the best production and hardiness trees of both varieties should be planted only on trifoliate-orange stock.[7]

In light sandy soils, especially from central Florida southward, where the trifoliate stock is unsuited, the sweet orange appears to be the next best Satsuma stock commercially available.

The tangerine ranks with the Satsuma as the most important of the kid-glove oranges. The Dancy is the only variety of tangerine grown commercially. Its season is December to March, while the Satsuma varieties mature from October to November.

The King, a large-fruited rough-skinned variety of the kid-glove sort, is grown occasionally as a fancy fruit. It is excellent in dessert quality as grown on hammock soils and other heavy Florida soils suited to the sour-orange stock, but on the light soils of southern Florida it is usually of inferior quality.

LEMON VARIETIES.

Lemons can be grown commercially only in the warm sections of Florida, as the trees may be frosted where the temperature falls below 28° F.

The Lisbon is a favorite variety. In favorable locations the tree is a vigorous grower and usually prolific. Most of the crop matures during the winter months.

The Villafranca is perhaps the most commonly planted of the lemon varieties in Florida. The tree is a vigorous grower, with few thorns, and is usually productive.

The Ponderosa is a valuable variety for the home grove. It is an extremely large sort, the fruits often weighing 2 pounds.

LIME VARIETIES.

The Florida lime crop is gathered almost entirely from seedling trees grown on the keys and in other tropical regions of southern

---

[6] Tanaka, Tyozaburo. Varieties of the Satsuma orange group in Japan. U. S. Dept. Agr., Bur. Plant Indus., Off. Crop Physiol. and Breeding Invest. Cir. 5, 10 p., 2 figs. 1918.

[7] Swingle, W. T. The limitation of the Satsuma orange to trifoliate-orange stock. U. S. Dept. Agr., Bur. Plant Indus. Cir. 46, 10 p., 6 fig., 1 pl. 1909.

Florida. The fruits of these seedling trees are quite variable in size and shape and are known commercially as Mexican or key limes. Some ripen every month in the year, but the main crop is harvested in the summer. The propagation of the best types by budding would doubtless lead to the production of larger and finer crops than are secured from the seedling trees commonly planted. (Fig. 4.)

The Tahiti variety is a budded sort that has been planted recently in southern Florida. It is a somewhat stronger grower and a trifle more hardy than the Mexican seedling limes. The tree is vigorous and usually is a prolific bearer. The fruit is similar in size and appearance to a small lemon. It is of excellent quality for home use and may eventually become of commercial importance, although at present the northern trade prefers the smaller key limes.

FIG. 4.—A well cared for lime grove at Upper Metacombe Key, Fla.

KUMQUAT VARIETIES.

The varieties of kumquats grown are the Nagami and Marumi. The Marumi bears small spherical fruits, while the Nagami bears larger oval-shaped fruits and is preferred to the Marumi for all commercial planting.

The Meiwa variety recently introduced is of the highest quality for eating in the fresh state. In size it resembles the Nagami, but it is more nearly spherical in shape.

NEW VARIETIES OF CITRUS FRUITS.

A number of interesting new fruits have been originated by the crossing of various citrus parents.[8] Among the most promising of

[8] Swingle, W. T., and Robinson, T. R. Tangelos: What they are. The value in Florida of the Sampson and Thornton tangelos. U. S. Dept. Agr., Bur. Plant Indus., Crop Physiol. and Breeding Invest. [Cir.] 4, 3 p. 1918.

these fruits is the tangelo, a hybrid of the tangerine and grapefruit, the Sampson being the favorite commercial tangelo of this group of hybrids; the Eustis limequat,[9] a hardy cross between the Mexican lime and the kumquat, the fruit of which is much like the lime in character and is produced over a long period of the year; and the citranges, a group of hybrids between the sweet orange and the trifoliate orange, which are of considerable value as hardy substitutes for the lemon and as ornamentals in regions too cold for growing even the hardiest of standard citrus varieties.

New varieties of citrus fruits originating as chance seedlings or bud sports or brought to light by foreign exploration are claiming attention from time to time. The Temple orange is a new variety recently brought to light at Winter Park, Fla. It is characterized by a deep-red color, thin rind, rather large size, and somewhat flattened shape. It is a midseason variety. Some extensive plantings of this orange have been made in recent years, but commercially it is not yet fully tested. It appears to be better adapted to sour-orange than rough-lemon stock. The Golden Ring is another highly colored orange of rather small size, maturing early, that is being planted in some sections. Although new varieties when promising ought to be tested, such new sorts should not be exclusively planted until they have demonstrated by their behavior in a practical test for each locality and soil type that they are superior to existing standard varieties in some leading characteristic, such as season, dessert or shipping quality, or hardiness.

PROPAGATION OF CITRUS TREES.

CITRUS STOCKS.

Citrus trees for planting are usually budded on sour-orange, rough-lemon, and other seedling stocks. The problem of selecting the best stock is of great importance, for in case an unsuitable stock is used the value of the grove may be permanently impaired. Sweet-orange seedling stocks were formerly used very extensively, but as they have been found very susceptible to foot-rot they are now seldom planted.

The sour orange, a hardy species of citrus, which is frequently found growing wild in Florida forests, is the leading stock in Florida as well as in California and most of the citrus-growing regions of the world. It is vigorous and resistant to foot-rot, and the trees produce thin-skinned fruit of fine quality which holds on the branches late in the season. In Florida sour-orange seedlings are the favorite stocks for hammock and flatwoods soils as well as the best grade of pineland. Most growers prefer sour-orange stock wherever soil conditions permit its use.

On light, dry, sandy soils in southern Florida, where sour-orange stock lacks thrift, the rough lemon, a vigorous-growing species of citrus related to the common lemon of commerce, is used. Trees on rough-lemon stocks make a very vigorous growth and on very light soils are easier to care for and require less fertilizer than trees on sour-orange roots. Rough-lemon stocks are tender and not suf-

[9] Swingle, W. T., and Robinson, T. R. Two important new types of citrus hybrids for the home garden, citrangequats and limequats. Jour. Agric. Research, v. 23, no. 4, Jan., 1923.

ficiently hardy for Gulf State sections colder than southern and central Florida. Under favorable conditions trees on rough-lemon stock usually are vigorous and productive, but it is claimed by many growers that the life of such trees is shorter than on some other stocks. The fruit produced by trees on rough-lemon stock, while often good in dessert quality, is frequently inferior to that grown on sour orange, and it can not be held on the tree so late in the season. Tangerine trees grown on it will usually not hold their fruit after the middle of January. The Parson variety of orange is seldom successfully grown on rough-lemon stock.

Grapefruit seedlings have been used as stocks to a limited extent in southern Florida. They are too tender for the colder sections of the State. This stock is more vigorous in growth than the sour orange but less vigorous than the rough lemon. It is best adapted to moist soils, well supplied with humus. As grapefruit seedling stocks are less hardy and less resistant to disease than sour-orange stocks, the latter are generally more satisfactory.

The trifoliate orange, formerly known as *Citrus trifoliata*, is the hardiest stock for citrus fruits in common use. It is deciduous and has a distinct dormant season in the winter. This dormancy has the effect of checking the winter wood growth of varieties budded on it, causing them to be less susceptible to low temperatures. For this reason trifoliate-orange seedlings are much used as stocks in the colder sections of the Gulf States. They are rarely desirable as stocks in southern and central Florida and have given unsatisfactory results in the Rio Grande Valley section of Texas, where the sour orange is the preferred stock for all varieties.

The trifoliate-orange stock is best adapted to rich moist soils and is unsuited to light dry soils. It is particularly well adapted to sandy loam soils with a clay subsoil. On the proper soils it produces thin-skinned fruit of high dessert quality. It has a tendency to dwarf the growth of the tree budded on it. In the lower Mississippi Delta, Washington Navel oranges are frequently budded on trifoliate-orange stock, and while the growth is less vigorous in that locality they are more prolific than when budded on sour-orange stocks. Two other stocks occasionally used and apparently possessing much merit in some sections of Florida are the bitter-sweet orange and the Cleopatra mandarin. The latter has the advantage in the nursery of immunity to citrus scab and at the same time possesses the attributes of the sour orange in resistance to foot-rot and in hardiness.

Lemon and lime seedlings are occasionally used as citrus stocks, but are too tender for general planting.

SELECTION OF BUDWOOD.

The source of budwood used in propagation is an important consideration.

Investigations conducted in California by the United States Department of Agriculture have shown that there is a great degree of variation within the standard citrus varieties grown in that State. When these variations of trees or fruit are very marked they are known as strains. Each strain, while retaining the general characteristics common to the variety, has clear-cut differences, either in

character of fruit, foliage, habit of tree growth, or production of fruit, so that it can be easily distinguished from other strains of the same variety. Furthermore, the trees of some strains are more prolific and bear much finer fruit than other strains of the same variety.

These investigations have also shown that trees propagated with selected buds from parent trees of these best strains perpetuate the characteristics of these desirable strains and come into bearing earlier and bear heavier and more uniform crops than trees propagated from buds which are not so carefully selected.[10]

Similar differences have been found to exist in the various varieties of citrus fruits grown in the Gulf States. In purchasing citrus trees for planting, growers should ascertain that they have at least been budded from trees which are true to the varietal name and, if possible, from trees which have a reputation for producing large quantities of fine fruit.

Growers and nurserymen interested in the methods of securing records from parent trees and in the subject of bud selection in general can secure detailed information by writing to the Office of Horticultural and Pomological Investigations, Bureau of Plant Industry, United States Department of Agriculture, or by requesting from the Division of Publications, United States Department of Agriculture, Farmers' Bulletin 794, entitled "Citrus-Fruit Improvement: How to Secure and Use Tree-Performance Records."

NURSERY METHODS.

Citrus trees for planting are usually purchased from commercial nurseries, and few growers to-day propagate their own trees. Seeds of sour-orange, rough-lemon, and other citrus fruits used as stocks are extracted from the fruits and sown in well-prepared seed beds. This sowing is usually done in December and January, except in the case of trifoliate-orange seeds, which are more commonly sown in September and October. The seeds are sown in rows about 2 feet apart, and the young seedlings are well fertilized and cultivated until they are large enough for transplanting. When the seedlings are 1 year old and 6 to 15 inches high, or when they are 2 years old and 15 to 24 inches high, they are transplanted to nursery rows. These rows are about 4 feet apart, with the trees a foot or more apart in the rows. After one or two seasons in the nursery row the seedlings will measure half an inch in diameter at the crown, and they are then ready for budding.

Budding may be done at any season when the bark slips readily. The ordinary shield-bud method is used in much the same way as with apples and pears. Waxed cloth is commonly used for wrapping the buds. In the spring the seedling tops are cut away, and the growing bud shoots are tied and staked.

When the buds have made a growth of about 30 inches they are pinched back and thus made to branch. The budded trees are ready

---

[10] Shamel, A. D., Scott, L. B., and Pomeroy, C. S. Citrus-fruit improvement: A study of bud variation in the Washington Navel orange. U. S. Dept. Agr. Bul. 623, 146 p., 16 fig., 19 pl. 1918.

——— ——— ——— Citrus-fruit improvement: A study of bud variation in the Valencia orange. U. S. Dept. Agr. Bul. 624, 120 p., 9 fig., 14 pl. 1918.

——— ——— ——— Citrus-fruit improvement: A study of bud variation in the Marsh grapefruit. U. S. Dept. Agr. Bul. 697, 112 p., 14 fig., 11 pl. 1918.

——— ——— ——— and Dyer, C. L. Citrus-fruit improvement: A study of bud variation in the Lisbon lemon. U. S. Dept. Agr. Bul. 815, 70 p., 14 fig., 8 pl. 1920.

for planting in the permanent grove when 1 year old, although they are often left in the nursery row and sold when 2 or 3 years old. When thrifty and well grown, 1-year-old buds, i. e., trees that have made one season's growth in the nursery from the bud, are quite as satisfactory as older trees and are usually less expensive.

GROVE MANAGEMENT.

PLANTING THE GROVE.

Clearing.—Before planting, the land should be thoroughly cleared of all native growth. Occasionally some of the larger trees are left standing in order to save the expense of clearing or as shelter trees

FIG. 5.—Florida orange trees planted among the native growth of palmettos.

to protect the young groves from frost and sun (fig. 5). Such trees left in the grove, however, rob the young trees of water and plant food and seriously interfere with the ease of cultivation. Except in the extreme northern citrus regions where frost protection is of vital importance, it will be found a cheaper and much more satisfactory practice in the end to remove all the native growth and thoroughly clear the land before the grove is planted. After clearing, the land should be plowed moderately deep, harrowed and leveled, and the soil put in as good tilth as possible. It is usually advisable to fence the land as a protection from livestock.

On rich low ground an application of lime is often made after plowing, at the rate of 1,000 pounds of slaked lime to the acre. Ground limestone may be used instead, at the rate of 1 ton to the acre, applied a year or more before the trees are set. However, lime

is of doubtful value to citrus trees in Florida, and it should not be used in large quantities, especially on light soils.

Many growers advise the sowing of a cover crop on new land the summer before the trees are planted. This is an excellent plan, as the cover crop shades the bare land from the sun, and when turned under in the fall it adds humus and greatly improves the condition of the soil. When the ground is in good condition, however, the trees may be planted at once and cover crops sown later between the tree rows.

Planting season.—Citrus trees may be planted at any season of the year when the wood of the trunks is firm and they can receive proper attention as to water, protection, and other care. In Florida planting is usually done either in the winter, from December 15 to February 15, or in summer after the rainy season starts. The winter is preferred, as at that season the ground is cool and moist and the trees become well established before the spring drought begins.

Most nurserymen offer their customers expert assistance in the planting and care of young trees, and where the grower is inexperienced it is often an excellent plan to secure such advice.

Planting plan and distances.—Groves are usually laid out in square or oblong rectangles, with the tree rows intersecting each other at right angles.

Opinions differ greatly as to the best distance apart for planting citrus trees. No specific distance can be given, as the proper spacing depends upon the soil, the stocks on which the trees were propagated, and the variety planted. Many citrus groves have been planted too close. It is important to plant the trees far enough apart for convenience of spraying, cultivation, and other operations and so that the trees when fully grown will not shade and crowd each other.

A common distance for setting orange and grapefruit trees in Florida is 25 by 25 feet. In rich soils 30 by 30 feet is often preferred. A few growers set oranges and grapefruit 20 by 20 feet apart, or even closer, but such close planting is rarely advisable. Grapefruit trees often have a greater spread than oranges, and it is usually desirable, even on the same land, to space them at a greater distance. Tangerines are planted at the same distances as oranges. Satsuma oranges are set a little closer, frequently 20 by 20 feet or 15 by 20 feet. Lemons are usually planted 20 by 25 feet apart, limes 15 by 20 feet, and kumquats 10 by 15 feet.

In the other Gulf States citrus trees are planted considerably closer than in Florida, especially when budded on trifoliate-orange stocks, which somewhat dwarf the trees. This close planting is also advantageous as a protection against cold and winds. In these sections orange and grapefruit trees are commonly set 20 by 20 or 20 by 15 feet apart and Satsumas 15 by 20 feet apart.

Some growers have planted their trees close together with the intention of removing every alternate tree at maturity or when the trees begin to crowd. This close planting increases the production during the first five years or so after the trees come into bearing and sometimes gives excellent results. Unless the grower has the courage, however, to cut out the alternate trees before they begin to interfere with each other, he will do best to confine his planting to the standard distance. But sometimes large bearing trees are transplanted profitably to new locations.

Wherever more than one variety of citrus fruit is planted, each sort should be in a block by itself. It is much easier to harvest the fruit and to spray effectively when the trees are set in this way than where several varieties are mixed together.

After the ground has been prepared a stake should be set where each tree is to be planted. The tree rows should be laid out with great care in order to have them exactly straight. For large plantings the services of a surveyor may be secured. The inexperienced grower will find little difficulty in obtaining competent advice on this matter of laying out the grove. (Fig. 6.)

Setting the trees.—It is best to plant the trees as soon as possible after they are received from the nursery. If planting must be delayed the trees should be removed from the boxes or bales in which they are shipped and heeled in to prevent the roots from drying out. The roots should never be permitted to become dry, even for a short

FIG. 6.—A well laid out 2-year-old citrus grove at Lucerne Park, Fla.

time. When they are taken to the field for planting they should be kept covered with wet sacking or carried in a barrel half filled with water.

The holes dug for the trees should be of ample size to receive the roots without crowding and should be dug at planting time, or at most not more than a day or so before the trees are set, as otherwise the soil will dry out too much. Just before they are planted all bruised and broken roots should be trimmed from the trees with a sharp knife. The trees should be set at the same level or an inch or so higher than they stood in the nursery. If set deeper the roots fail to make the best growth. The roots should be evenly spread out in the bottom of the hole and surface soil packed among them until they are well covered. It is very essential that this soil be well firmed and packed so that it is in close contact with the roots. Many growers mix in a pound or so of good commercial fertilizer with the soil used for filling the tree holes. Stable manure should not be used in direct contact with the roots at planting time, as it is sometimes injurious to young citrus trees (fig. 7). In marl soils, however, manure well worked into the tree mounds before planting

has proved decidedly beneficial. After the hole is filled with well-packed soil a shallow basin should be made about the tree (fig. 8) and 5 or 10 gallons of water applied (fig. 9). To prevent the evaporation of moisture this basin should then be covered with a mulch of grass, leaves, or dry soil. When there is danger of frost, the basin should be omitted and the trees mounded with soil so that the lower portion of the tree up to a point well above where it was budded on the stock is protected from the cold. If the top is frozen back to the mound a new top can be developed from the protected

FIG. 7.—Planting a citrus tree, using a planting board. The trees are carried in a half barrel of water on the wagon until ready to go into the ground.

part of the trunk. Dry, clean sod, free from waste or litter, should be used, as trash frequently attracts wood lice. As soon as the danger from cold is over, the mounds should be removed, as soil left mounded about the trunk in hot weather may favor bark diseases.

After the trees are planted they should be watered from time to time whenever their appearance indicates the need. Except during the rainy season the ground should be cultivated so that a dust mulch is formed and evaporation checked.

Pruning the trees at planting.—As soon as the young trees are planted, the tops should be cut back to make up for the heavy pruning which the roots have received in transplanting, as the balance between the root system and the top must always be maintained.

Trees with a single unbranched stem are headed back to a bud at a height of 2 or 3 feet from the ground. Most growers prefer the lesser distance and make low-headed trees. Three or four lateral branches, well distributed about the upper 12 inches of the tree, should be permitted to grow and all other branches removed as soon as they start. When the trees are planted with a top already formed, the undesirable branches should be pruned off and only three or four desirable limbs left. These should be cut back to spurs with two or three buds on each spur. Weak trees and trees which fail to start readily after planting should be pruned still more severely. Trees that are well headed at planting time and carefully pruned for the next few years will need very little pruning after they reach maturity.

After the grove is planted it is an excellent plan to make an accurate diagram, showing the location of each tree and variety.

FIG. 8.—Making a shallow basin around a citrus tree after planting. This basin will be filled with water and finally covered over with a mulch of dry earth.

SYSTEMS OF MAINTAINING SOIL FERTILITY.

A system of soil management should be planned which will add humus to the soil, conserve moisture and fertility, and maintain the soil in the best condition for tree growth. The best system of cultivation will depend upon the particular conditions in each grove.

CLEAN CULTIVATION AND THE COVER-CROP SYSTEM.

Clean cultivation throughout the year, once widely practiced in Florida, has been abandoned, as it was eventually found that this method rapidly depleted the essential humus content of the soil. The most widely used system of handling soil in Florida is that of combining clean cultivation in the dry season with cover crops during the summer rainy season.

The main object of clean cultivation is to form a mulch of dry soil, so as to prevent the evaporation of moisture from below. This dust mulch is secured by plowing or disking the grove in the fall

and harrowing at intervals of 10 days or 2 weeks throughout the dry season. It is only necessary to stir the upper 3 or 4 inches of the soil to get an effective dust mulch. Deeper tillage may injure too many of the feeding roots of the trees. Plowing should never be deep, especially in light soils. Many of the best growers never use a plow in their groves, depending entirely on the disk harrow, followed by the acme harrow.

When the summer rainy season begins, cultivation is discontinued and a cover crop sown or a volunteer growth of weeds and native grasses allowed to spring up. This cover crop grows during the summer and the following October or November is plowed or disked under to add humus to the soil. Occasionally cover crops are left on the ground through the winter, but this is a questionable practice because of the danger of fire. In case the cover crop is rank or green it should be cut with a mowing machine and allowed to wilt before it

FIG. 9.—Watering citrus trees immediately after planting.

is turned under. The cover crop should not be removed from the grove, but should be worked into the soil to improve its physical condition.

Some growers rely entirely on weeds for the cover crop, but most prefer to sow velvet beans, beggarweed, or cowpeas. All of these are leguminous crops, and in addition to adding humus to the soil they also add considerable nitrogen, which they derive from the air.

Velvet beans should be planted before the last of April for the best results. They may be sown broadcast, but it is preferable to plant them in drills or hills and cultivate the ground until they start. The bush velvet bean should be planted, as the ordinary vining varieties require some effort to keep them from running over the trees.

Beggarweed is an excellent cover crop, especially in Florida. If not cut too early in the fall it is self-seeding and will come up every year. Sometimes two or more cuttings can be made the same season. Each cutting should be left to enrich the soil.

Cowpeas are a favorite cover crop in the Gulf States except in Florida, where they are only occasionally used. The Iron and Brab-

ham varieties are the best to plant, as they are resistant to nematodes. In some sections the fine-leaved varieties of the soy bean, such as the Laredo and Otootan, are proving valuable as green-manure and cover crops.

One objection to these leguminous cover crops is that they attract pumpkin bugs, sometimes a serious pest on citrus trees. When pumpkin bugs are numerous the cover crop should be cut by September 15. The cover-crop growth close to the trees and between the trees in the tree rows should be cut first, using a scythe where necessary. The pumpkin bugs, few of which are able to fly or travel far at this season, will then be forced to concentrate in the cover crop still standing in the row middles. When this part of the cover crop is cut the bugs are destroyed before they reach the dangerous stage.[11]

In southern Alabama and Mississippi some modifications of the cover-crop system followed in Florida groves have been found necessary. These modifications apply to the Satsuma orange on the trifoliate-orange stock, a highly specialized form of citrus industry.

Experience in this section has proved that in young groves (up to 6 or 8 years old) it is not wise to cease cultivation with the beginning of summer and allow a cover crop, volunteer or planted, to grow throughout the summer months. Cultivation is continued well into July, when a cover crop, such as cowpeas, is planted, preferably in rows, so that one or two cultivations can be given. This cover crop is turned under in the fall and the grove put in good tilth for the winter.

Where the soil is subject to washing a winter cover of rye or oats should be used. This system with adequate applications of well-balanced fertilizers results in the trees going into the winter in a vigorous condition, enabling them to stand low temperatures much better than trees weakened by inadequate cultivation and fertilization.

MULCHING SYSTEM.

A mulching system is used successfully by some citrus growers. Until about the tenth year clean cultivation in combination with cover crops is practiced, and after that time the weeds and grasses are allowed to grow the year round. The weeds are mown once or twice a year and left on the ground as a mulch. Leaves, hay, and other materials are sometimes brought into the grove and added to this natural mulch. Very fine fruit is produced by this mulching system, especially on moist hammock soils, but in nearly all groves the combination of clean cultivation with the cover-crop system will give better results.

FLAT-HOEING SYSTEM.

In a few groves all of the tillage is done with hoes. The weeds and grasses are cut off frequently at the surface of the ground and left as a mulch. This system, known as "flat hoeing," is most widely practiced on the rocky limestone soils of Dade County, Fla., where ordinary cultivation with harrows is impracticable.

---

[11] Watson, J. R. Insects of a citrus grove. Fla. Agr. Exp. Sta. Bul. 148, pp. 165–267, figs. 75–142. 1918.

INTERCROPS IN THE GROVE.

Profitable interplanted crops may sometimes be grown in the groves while the trees are young and before they require all the space. The land next to the young citrus trees should be kept cultivated and only the row middles used for the production of these intercrops. Work animals used in such plantings should at all times be equipped with muzzles to prevent their grazing on the trees, frequently a cause of much injury.

On fertile soils truck crops, such as lettuce, beans, or cabbage, may be grown. In Florida, Natal hay and other forage crops are sometimes grown between citrus trees, but this practice is not to be recommended. Peaches are occasionally planted as intercrops and bear three or four crops before they are cut out. None of these intercrops should be planted close to the young citrus trees or allowed to impoverish the soil. Care must be taken, especially in growing vegetable intercrops, that the heavy fertilization does not overstimulate the citrus trees.

FERTILIZERS.

Most of the citrus soils in the Gulf States require the addition of fertilizers for the production of the most profitable fruit crops. The kind, quantity, and frequency of application of such fertilizers are all much-debated questions. They vary so greatly in each grove that only the general principles of citrus fertilization can be set forth in this bulletin.

The newcomer in a citrus section should consult growers of long experience in his locality and be guided by their advice in fertilizing his grove. He should also experiment for himself in the use of the various fertilizers, so as to determine the best combination and quantities for his conditions, which may differ from those even in adjacent groves. No cultural problem is more important or demands closer study on the part of the grower than that of fertilization.

The necessary elements of plant food which must be added to the soil in fertilizers are nitrogen, phosphorus, and potash. Nitrogen plays an important rôle in the production of new wood and leaf growth. Deficiency of nitrogen is indicated by yellow foliage and stunted growth of the tree. Excess of nitrogen, on the other hand, results in what is termed die-back, which causes the fruit to become thick skinned and puffy. The principal sources of inorganic or mineral nitrogen are nitrate of soda and sulphate of ammonia. The former is very quick in its action, while with sulphate of ammonia the effects are much slower. The chief sources of organic nitrogen are cottonseed meal, tankage, dried blood, and other plant or animal material. These are slower in their action than most inorganic nitrogenous fertilizers, and they must be used with care to avoid die-back. Nitrogen is also supplied to the soil in considerable amounts by velvet beans, cowpeas, and other leguminous cover crops.

Phosphorus is considered necessary for the proper development of the fruit. The chief sources of this element are bone and acid phosphate.

Basic slag, also known as Thomas phosphate, and ground raw phosphate rock are sometimes used as sources of phosphorus with

good results on very heavy acid soils rich in humus. On nearly all Florida citrus soils, however, their action is too slow to make them either cheap or desirable fertilizers.

The common sources of the element potassium are sulphate and muriate of potash. The sulphate form is preferable, since the muriate sometimes has an injurious effect on citrus trees.

During the war with Germany potash became very scarce, and growers who formerly used 10 per cent or even more of this element in their fertilizer mixtures were unable to secure such a large percentage. A reduced quantity of potash has now been used for several seasons, but without apparent detriment to the trees or the fruit. As a result of their experience most citrus growers are continuing the application of this reduced amount of potash, using from 5 to 8 per cent of this element instead of the much greater proportion formerly applied.

FERTILIZERS FOR YOUNG TREES.

In Florida the usual practice is to fertilize young citrus trees three or even four times annually. The first application is made in the spring at the time the first flush of growth starts. One or two applications are made in summer and the last early in September. The spring and summer applications contain about 5 per cent of nitrogen, 6 to 8 per cent of phosphorus, and 2 or 3 per cent of potash. For the last application in the early fall the nitrogen is reduced to 2 or 3 per cent, in order to permit the trees to harden up in good shape for winter.

The total fertilizer used on trees the first year they are set is from 1 to 2 pounds. This is increased about a pound a year until the trees are 5 or 6 years old and begin to bear commercial crops of fruit.

FERTILIZATION OF BEARING TREES.

With bearing trees relatively less nitrogen is used than with younger trees, as it is not desirable to force wood growth. Three applications a year are usually made with mature trees. The spring and summer applications contain 3 or 4 per cent of nitrogen, 7 or 8 per cent of phosphorus, and 5 to 8 per cent of potash. The last application for bearing trees in Florida is made between November 15 and December 15 and contains but 2 or 3 per cent of nitrogen, with the same amounts of the other elements used in the spring and fall applications.

Bearing orange trees when 10 years old receive from 15 to 30 pounds of fertilizer a year. This quantity is increased as the crops become larger. Large bearing trees receive from 30 to 75 or more pounds of fertilizer annually. Many growers fertilize grapefruit somewhat more heavily than oranges.

The quantities of fertilizer used will vary with the type and fertility of the soil. Those specified above are applicable to soils of medium fertility, such as the best class of Florida high pineland. On lighter, sandier soils the amount of fertilizer is increased 25 per cent or more, while on rich hammock soils it is reduced 25 per cent or even more. On rich soils it is also often advisable to reduce the relative proportion of nitrogen used in the formula. Where nitro-

gen-collecting leguminous cover crops are grown the amount of commercial nitrogen applied may also be somewhat reduced.

Trees that have been overfertilized may become affected with die-back. Die-back is nearly always combined with excessive growth and overfeeding, in contrast to mottle-leaf, or frenching, which affects weak, insufficiently nourished trees. The fruit on trees affected with die-back is coarse and puffy, or is "ammoniated," as the grower would say, and the young growth is often sickly and abnormal. Where such a condition exists, the amount of fertilizer should be reduced and cultivation stopped until the trees recover their normal condition.

Sometimes die-back is due to hardpan, poor drainage, or other unfavorable soil conditions, which must be remedied before the trees can permanently recover.

Copper sulphate (bluestone) has been found an effective aid in correcting some forms of die-back. It should be used in finely granulated form, well distributed over the root-feeding area, not closer than 1 foot from the trunk of the tree. The dose should vary from a few ounces for young trees to a maximum of 3 pounds for large trees.

METHODS OF APPLYING FERTILIZERS.

Fertilizers should be spread evenly over the ground and then cultivated into the soil. Some growers broadcast their fertilizer by hand, but a fertilizer distributor is preferable, especially when the grove is large. The fertilizer should be distributed well out over all the ground shaded by the branches, so that the entire widespreading root system may be reached. In mature groves practically all the ground should receive fertilizer, while with very young trees it is only necessary to spread the fertilizer over a strip 3 or 4 feet wide on either side of the trunk. Care must be used to see that the fertilizer is kept a foot or two away from the trunks, as it is sometimes injurious to the crown roots.

BARNYARD MANURE.

In Florida the opinion prevails that barnyard manure is injurious to citrus trees and that its use frequently results in die-back. It is true that stable manure may have a bad effect, especially on trees growing in light soil, when it is applied in large quantities. When applied in small quantities, however, it is often one of the best fertilizers for citrus trees. Besides adding humus, stable manure promotes beneficial bacterial action in the soil.

Stable manure may be used profitably in somewhat heavier applications on heavy soils than on light, thin soils. On the comparatively heavy soils of California, as well as in Alabama and Louisiana, it is used in large quantities in the citrus groves with excellent results. On the lighter Florida soils the organic nitrogen of stable manure becomes available much more quickly than on heavier soils. For this reason stable manure must be used in smaller quantities on light soils in order to prevent overstimulation of the trees.

Lime is sometimes beneficial, especially on heavy soils rich in humus, but it must be used with caution, as heavy applications

release plant food too rapidly, with the result that the soil becomes burned out and the tree growth impaired. On light citrus soils the use of lime is rarely advisable.

There are indications that citrus trees affected with the so-called mottle-leaf may be benefited greatly by a judicious use of stable manure. Mottle-leaf, or frenching, is of very common occurrence in Florida citrus groves. The affected trees have a general sickly, backward appearance, and the leaves show pronounced splotches of yellow between the veins and the midribs. In many cases the trouble seems to have originated through a too rapid depletion of soil humus, following applications of lime or intensive cultivation. Consequently, lime must be used with care on light soils. In the investigations mentioned above, it has been shown that mottle-leaf may be overcome and the trees restored to normal condition by the application of light amounts of stable manure combined with the growing of cover crops so as to restore the soil humus content.

Trees which by a general sickly appearance and yellowish leaves indicate a lack of nitrogen may also be benefited by several light applications of manure.

PRUNING CITRUS TREES.

When properly headed at planting time citrus trees require little pruning later. The general methods of pruning the trees when they are first set out were described in connection with the planting directions.

The pruning given during the first few years of the tree's life should be a continuation of that started when the trees were planted. All undesirable branches should be removed while they are still small and three or four limbs developed as a framework. Long, weak limbs that do not show a tendency to branch should be headed back, so that the tree will be kept strong, compact, and symmetrical. The top of the tree should not be allowed to become too dense, while on the other hand it should not be left so open that the trunk and inside branches are exposed to sun scald. Whenever it is necessary to prune off limbs whose removal will leave the inner branches exposed to the sun, the exposed branches should be protected from sun injury by a liberal coat of whitewash applied to reflect the heat. Bearing trees well cared for will need but little pruning. This pruning may be done at any time of the year when most convenient. Most growers prune in summer when other work is slack. The most important object is the removal of all dead, decayed, and injured wood. Such wood when left provides a breeding place for the fungus which causes melanose and stem-end rot, and the removal of this wood will tend to reduce the chances of these diseases developing. Figure 10 shows a convenient method for economically removing brush and prunings from the grove.

It is best to maintain trees in good shape by doing what pruning is necessary every year, as heavy pruning is objectionable. However, it is often advisable to prune severely trees long neglected in order to put them into shape for good production. After a heavy pruning of this sort a vigorous growth of suckers, or water sprouts, will appear. These should be thinned out, leaving only such as may be desired for developing into permanent branches. Sometimes a

few water sprouts are left along the trunk and inner limbs and pinched back to form short inner fruiting branches. With most trees, however, the shade is too dense to favor much fruiting of these inner branches.

The principal tools used in pruning are the hand shears, knife, and saw. All tools should be kept as sharp as possible. It is very important to make the cuts clean and close to the trunk or branch left. Stubs should never be left, as they do not heal over well and eventually cause weak places in the tree. The large cut surfaces may be coated over with liquid grafting wax or white-lead paint.

Frozen trees should be pruned well back to good sound wood as soon as the extent of the injury is apparent, which will usually be

FIG. 10.—Removal of prunings from a grove for burning, Isleworth, Fla. This labor-saving contrivance materially reduces the cost of removal.

within a few weeks after the freeze. Benefit is secured not only through stimulation to new growth, but from the protection afforded against melanose and other diseases.

IRRIGATION.

In many of the Gulf coast sections a dry spell is frequently experienced during the spring months. These droughts are often the cause of damage to citrus trees, and some growers have resorted to irrigation as a means of insuring the setting of a good crop of fruit. (Fig. 11.)

In planning the installation of a system of irrigation the fact must be taken into account that in some years no long droughts occur and irrigation is unnecessary. The total expense of installing and maintaining an irrigation plant must be balanced against the advantages gained during the years when it is actually needed. It is therefore best to use as simple and inexpensive a system as will do the work. In many locations in Florida an efficient irrigation system for citrus

groves can be cheaply installed, and most growers who have such systems consider them profitable investments.

Information concerning the irrigation of citrus groves in Florida can be obtained by writing to the United States Department of Agriculture for Department Bulletin 462, entitled "Irrigation in Florida."

PROTECTING GROVES FROM FROST.[12]

The freezes of 1895, 1899, 1917, and other years demonstrated to the citrus grower in the Gulf States the importance of being prepared to protect his trees from frost damage.

Young trees should always be mounded in localities where killing frosts occur. In the freeze of February, 1917, thousands of young

FIG. 11.—Furrow irrigation in a citrus grove, Orlando, Fla.

unmounded trees were frozen to the ground. In the case of properly mounded trees in the same localities new shoots sprang from above the buds and the trees were restored with very little loss of time. An exception should be noted in the case of the Satsuma on trifoliate-orange stock. Mounding Satsuma trees is a practice of doubtful value. In the freeze of 1917 in Alabama more injury was done to trees that were mounded than where no such protection was afforded, the freezing of the wet soil in contact with the bark causing severe damage in many cases.

Many methods of frost protection have been advocated for citrus groves. Individual tents and sheds for entire groves have been

[12] The reader should consult Farmers' Bulletin 1096, Frost and the Prevention of Damage by It, which may be obtained free upon application to the Division of Publications, Department of Agriculture, Washington, D. C.

tried, but were found too expensive and cumbersome. The principal methods of protection now used in the Gulf States are wood fires and coke or oil heaters. With each of these methods it has been found that it is the heat supplied and not the smoke or smudge that gives the protection.

In the course of a survey made of the Gulf States citrus sections immediately after the freeze of 1917 the results obtained by all of these methods were studied and compared. It was found that in practically every case where wood fires were used with care and intelligence very satisfactory results were obtained, even under the most trying circumstances.

WOOD FIRES.

A very striking example of the efficiency of wood fires when properly handled was shown in the 10-acre grove of L. D. Jones, near Orlando, Fla. This grove was exposed to the full sweep of the wind and a minimum temperature of 22° F. Half of the grove was heated by a large wood fire in every alternate square of trees. In this area practically no damage was done. Trees, fruit, and even some blossoms remained uninjured. In striking contrast to this part of the grove, the unprotected half was severely damaged.

The objection is sometimes made that wood firing is not suitable in a large grove on account of the labor involved. Several very large groves, however, were efficiently and cheaply fired with wood. One grove of more than 300 acres was successfully carried through a temperature of 21° F.

For wood fuel, pine logs and pine and oak stumps are frequently used. Some growers used discarded railroad ties, which they obtain for the expense of hauling.

Growers who fired two or three nights during the freeze of 1917 used from 10 to 15 cords of wood to the acre, at a cost of about $2 a cord. The quantity used was in proportion to the exposure of the grove and the temperature experienced. In old thickly planted groves less fuel was used than in young and open plantings. The total labor cost, including the cost of hauling in wood and preparing the fires, averaged about $10 an acre, making the total cost of fuel and labor for two or three nights of firing about $40 an acre.

The most commonly used material for lighting wood fires was chips or waste from turpentine stills. A few growers used kerosene torch lighters with much success.

Most growers stow their wood in piles just outside the grove until the beginning of the danger season, when it is carried into the grove and piled in position for use. One pile in every square of four trees is usually made, particular attention being given to the north and west side of the grove. In many cases it is not necessary to light more than each alternate pile until the cold becomes intense.

For lighting and caring for wood fires in small groves one man will be needed for every 2 acres, while in larger groves with better organization and equipment one man should care for 3 acres or even more.

OIL HEATERS.

Oil heaters were used in a number of groves, but failed to give satisfaction in many cases. This was due in part to the inexperience

of the growers in handling oil. The most satisfactory type of heaters were those of large capacity, holding 9 gallons or more of oil. Too much refilling was necessary where small oil reservoirs were used.

In a number of instances growers attempted to use heavy oils which had been stored for a number of years and which had become so thick that they could not be lighted. Light distillates, on the other hand, were found to be in excellent condition, even after long storage.

The chief advantage of oil heaters as compared with wood fires is that the former, when skillfully handled, often give better regulation of temperature, and the fires can be started more quickly and with less labor. On the other hand, the initial cost is very high, often exceeding $200 an acre. It is believed that for the Gulf States wood will give much more satisfaction as to cheapness and efficiency than oil.

COKE HEATERS.

Coke heaters have been used by several growers with success. The coke is burned in metal stoves of special construction.

SPRAYING CITRUS TREES.[13]

Citrus trees in the Gulf States are affected by a number of insect and disease pests. Most of these can be controlled or eliminated by proper grove sanitation, pruning, and spraying. Spraying is now recognized by most successful growers as essential to the profitable production of high-class bright fruit, as well as for the growing of healthy, vigorous trees.

The spray schedules shown in Table 3 for grapefruit and orange trees are believed to represent the minimum number of applications that will prove effective in average years for the commercial control of fungous and insect pests.

Further information concerning the nature and control of citrus diseases and insect pests in Florida and the other Gulf States may be obtained by writing to the United States Department of Agriculture, Washington, D. C., or to the appropriate State agricultural experiment station.

REJUVENATION OF OLD GROVES.

Many of the older citrus groves in the Gulf States are no longer bearing as profitable crops as they did in former years. In many groves this deterioration, usually due to neglect, is very noticeable.

Where old trees are in very bad condition, especially when they are affected with foot-rot, it is usually best to grub them out and make a fresh start with young trees of standard budded varieties. If the trunks are in sound condition, however, a thorough pruning, followed by cultivation, fertilization, spraying, and general good orchard management, will often bring run-down trees into profitable bearing in two or three seasons, provided there is no inherent fault in the soil or the locality.

---

[13] The information in this section was contributed by H. R. Fulton and J. R. Winston of the Office of Fruit-Disease Investigations, Bureau of Plant Industry, and W. W. Yothers of the Office of Tropical and Subtropical Fruit-Insect Investigations, Bureau of Entomology.

TABLE 3.—*Spray schedules for grapefruit and orange trees.*

GRAPEFRUIT.[1]

Application.	Time of application.	Material.	Enemies.	Remarks.
A	About Mar. 15 to Mar. 25.[2]	3–3–50 Bordeaux mixture plus one-half of 1 per cent oil as emulsion.	Scab, early melanose, scale crawlers, and white fly.	Only partially effective against severe scab outbreaks.[3] This is a good time to spray if grower can make but one application for scab control.
	or			
A	About Mar. 15 to Mar. 25.[2]	Lime-sulphur solution, 2½ to 3 gallons to 100 gallons.	Scab, red spiders, rust mites, and scale crawlers.	Has but little effect against scab but is desirable for its effect against insect pests.
B	Apr. 5 to Apr. 15...	Lime-sulphur solution 1½ to 2 gallons to 100 gallons.	Rust mites, sharkskin, tear-stain, and scale crawlers.	Probably not necessary if lime-sulphur is used in application A.
C	Apr. 25 to May 5[4]..	3–3–50 Bordeaux mixture plus 1 per cent oil as emulsion.	Melanose, white fly, and scale insects.	Usually quite effective against melanose.[5]
D	June 25 to July 5...	1 per cent oil as emulsion plus dry soda-sulphur, 2½ pounds to 100 gallons.	Rust mites and scales.	Very important if copper sprays have been applied during the season.
E	Sept. 1 to Feb. 1...	1 per cent oil as emulsion plus dry soda-sulphur, 2½ pounds to 100 gallons.	Scale insects, white fly, sooty mold, and rust mites.	Not always necessary.[6]

ORANGE.[1]

A	Apr. 20 to May 5...	3–3–50 Bordeaux mixture plus 1 per cent oil as emulsion.	Melanose, white fly, and scale insects.	Usually quite effective against melanose.[5] Probably not necessary on rather young trees where these enemies do not occur.
B	June 1 to June 15...	Lime-sulphur solution 1½ to 2 gallons to 100 gallons.	Rust mites, tear-stain, sharkskin, and scale crawlers.	The critical rust-mite application.
C	June 25 to July 5...	Oil 1 per cent as emulsion.	Scale insects	Very important if application A was applied.
D	Sept. 1 to Feb. 1...	Oil 1 per cent as emulsion plus dry soda-sulphur, 2½ pounds to 100 gallons.	Scale insects, white fly, sooty mold, and rust mites.	Not always necessary.[6]

[1] This spray schedule should be expected to give reasonably satisfactory results under the conditions in Florida in years when the diseases and insect pests do not occur in unusual abundance.

[2] In the last of the bloom, when about three-fourths of the petals have fallen.

[3] For more complete information on scab control where the disease occurs in quantity, see U. S. Dept. Agr. Bul. No. 1118, Citrus scab: Its cause and control, or Department Circular No. 215, Commercial control of citrus scab.

[4] At least 10 days should elapse between the lime-sulphur and Bordeaux-oil applications to avoid danger of injury.

[5] For more information on melanose control, see U. S. Dept. Agr. Circ. No. 259, Commercial control of citrus melanose.

[6] For detailed information on the control of Florida citrus insects, see Farmers' Bul. No. 933, Spraying for the control of insects and mites attacking citrus trees in Florida.

In the case of groves which become crowded with age or from too close planting, it is often of advantage to remove alternate rows. The trees taken out, if healthy, can be profitably reset in new ground.

Figure 12 shows a large tree a few months after transplanting. In two to three years such trees should be bearing profitable crops. The work is best done in the winter when the trees are dormant. It is important that a large basin be made around the newly set tree capable of holding a half barrel or more of water, and water should be supplied in abundance. The main roots should be cleanly cut 2 or 3 feet from the tree trunk and handled without bruising. Soil should be very carefully packed around the roots in resetting. The tree trunks and main limbs should be whitewashed in most cases as a protection against sun scald.

There are also many old groves, consisting of seedling or inferior budded trees, which might be very profitably budded or grafted over to standard varieties. Where the work is done carefully, such undesirable sorts can often be worked over within a few years into bear-

FIG. 12.—Tangerine tree, 20 years old, at Islesworth, Fla., a few months after transplanting.

ing trees of Pineapple, Homosassa, and other standard varieties, worth far more than the original trees.

In top-working undesirable trees of this sort two or three main limbs should be selected as a foundation for a new top. Additional limbs should be budded later, after the first buds have made a good start. The buds may be inserted directly into the bark of the limb itself at any season of the year when the tree is growing vigorously. Two or more buds are inserted at the base of each limb, and after these have made a good growth the old limb should be lopped off close to the new bud sprout. Grafting with the aid of paraffin by means of the Morris "slot-graft" method makes possible the insertion of grafts into old thick bark without sacrificing the top until the new graft has taken. Another method of budding large limbs is to cut them back to stubs a foot or so in length. Sprouts will soon start from these stubs, and after the sprouts are half an inch or more in diameter two or three buds may be inserted in each of them. One or

two of these buds are permitted to develop at the base of each limb, and the others are eventually removed.

Mature trees may also be worked over by the methods explained in connection with the treatment of frost-injured trees.

Old orange trees on sweet-orange stocks are often badly affected with foot-rot. Such trees should be grubbed out and replaced with new trees on sour-orange or other resistant stocks. When foot-rot has not advanced too far, however, it is possible to save the affected tree by planting small resistant seedlings in the ground near the base and inarching the tops of these seedlings into the trunk of the large tree.

FIG. 13.—A large seedling sweet-orange tree affected by foot-rot saved by bridge grafting with resistant sour-orange stock. Dunedin, Fla.

Figure 13 shows a fine, large, seedling sweet-orange tree which has been saved by changing its root system from the original sweet stock affected with foot-rot to resistant sour-orange stock by this method of inarching.

Incipient cases of foot-rot will often yield to treatment with Bordeaux paste or lime-sulphur concentrate after thorough cleaning of the bark wounds.

TREATMENT OF FROST-INJURED CITRUS TREES.

Trees that have been injured by cold often require severe pruning. Two or three weeks after the freeze the extent of the damage will be apparent, and the trees should then be cut back to sound, healthy wood. Cuts should be made clean and close to a growing limb or sprout whenever possible. The limbs or trunks when exposed should

be whitewashed or wrapped with burlap to protect them from the sun. After this pruning the injured trees should be carefully cultivated and fertilized, so that the most favorable conditions for the rapid recovery of the grove are afforded.

When the bark is badly split on the trunks and limbs as a result of frost, the loosened bark may be tacked down and tied in place with raffia or cord. When there is still some live adherent bark this treatment has given good results when performed immediately after the injury occurred, before the bark had time to dry out. Painting the trunk with grafting wax or similar material is seldom beneficial, and may result in actual injury when the area so covered is large.

Citrus trees when not banked or mounded are sometimes so badly injured by frost that it becomes necessary to cut them off at the surface of the ground below the bud. In that event the sprouts which start from the old stump may be shield budded in the same manner as seedling stocks. Some growers prefer to crown graft. This is done by first cutting the old stumps back to clean live wood an inch or so below the ground; two or more scions of the desired standard variety are then inserted between the bark and the wood, and the stump is banked with moist soil until the tops of the scions are nearly covered. If the scions fail to take, the sprouts which will start from the stump may be budded. Crown grafting is best performed when the trees are dormant in the winter or fall, while sprout budding may be done at any season of the year when the bark slips readily.

Where badly injured trees are budded or grafted by one of these methods, buds of the best-named varieties should be used. In many cases seedling trees after a freeze have been budded to standard varieties, with the result that within a few seasons the reworked trees were more valuable than before the freeze.

HARVESTING AND MARKETING CITRUS FRUITS.

The harvesting and marketing of citrus fruits is usually done by the fruit buyer or by one of the various cooperative associations rather than by the grower himself. The grower, however, should either superintend the operations in his grove and in the packing house or satisfy himself that the work is in competent hands, in order to insure that his crop may be handled in such a way that it can be marketed in the best possible condition.

Too much emphasis can not be placed on the necessity for care in the methods of handling citrus fruits at all stages. It has been shown in the course of investigations conducted in the Gulf States by the United States Department of Agriculture that much of the decay developing in citrus fruits prior to their arrival on the market is due to improper or careless methods of picking, packing, and shipping.

In clipping the fruit from the trees some style of clipper should be used that will not puncture the fruit. Picking boxes should be kept clean and free from projecting nails or splinters and gravel. The packing-house machinery should be thoroughly inspected and adjusted so that the fruit is handled with the greatest possible care. Punctures and bruises resulting from neglect of these precautions are responsible for a large proportion of the cases of fruit decay.

The loss from mechanical injuries can be in a large measure traced to the piecework system of picking and packing, i. e., payment by the box. The obvious remedy is a change to properly supervised labor paid by the day.

A recent packing-house development has been the installation of insulated rooms for the coloring of fruit, using the gas of incomplete combustion generated from oil stoves or the exhaust from gas engines for this purpose. In the case of some varieties, such as those of the Satsuma [14] type and the Parson, the development of flavor and sweetness takes place before the fruit is fully colored on the tree. In other cases, as with the Valencia when held late, fruits will often turn partially green even after once having attained full color. Such fruit is not only rendered more attractive to the consumer by coloring but a longer shipping season is made possible. The process is only legally applicable, however, to fruit that is already mature, as judged by the soluble solids-acid ratio,[15] and caution should be observed in any attempt to color fruit to make sure that only such mature fruit is used for this purpose.

Detailed information regarding the handling and shipping of citrus fruits,[16] including information on packing-house operations and precooling before transit, may be secured by addressing the United States Department of Agriculture. (Fig. 14.)

COSTS AND PROFITS IN CITRUS GROWING.

Many questions are asked as to the costs and profits in citrus growing. It is quite impossible to answer these queries satisfactorily for any particular case, for citrus culture as an investment is complicated and uncertain.

In Florida the cost of planting and caring for a citrus grove during the first four years, or until it reaches bearing age, ranges from $250 to $500 an acre. This is exclusive of the cost of the land, but it includes interest at 8 per cent on the money invested and payment for all labor done.

The price of unimproved citrus land in the Gulf States is governed by many factors, such as fertility, distance to city and shipping point, and the general standards and prosperity of the community. Desirable citrus land ranges in price all the way from $20 to $200, or even more, per acre. In some widely advertised localities the land has assumed a price too high for the conservative investor. By careful search the investor of limited means can locate desirable land at a comparatively low price, as there is plenty of low-priced land to be had in the less-developed communities.

The annual cost of maintaining a grove in Florida after it reaches bearing age averages from $75 to $150 an acre. When all or most of the labor is performed by the grove owner the cash expenditure of starting and maintaining a grove may be reduced a third or even more.

---

[14] Coloring Satsuma oranges in Alabama. U. S. Dept. Agr. Bul. No. 1158.

[15] U. S. Dept. Agr., Food Inspection Decision 182.

[16] Ramsey, H. J. Handling and shipping citrus fruits in the Gulf States. U. S. Dept. Agr., Farmers' Bul. 696, 28 p., 10 fig. 1915. Available for free distribution.

Stubenrauch, A. V., Ramsey, H. J., Tenny, L. S., and others. Factors governing the successful shipment of oranges from Florida. U. S. Dept. Agr. Bul. 63, 50 p., 26 figs., 15 pl. 1914. Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 20 cents.

The profits in citrus growing vary even more than the costs. The returns from some of the best groves are very high indeed, while, on the other hand, there are many poorly located or poorly cared for groves that are maintained at an actual loss.

Orange and grapefruit trees in good soils and well cared for come to bearing age at about the fourth or fifth year, when they commonly yield from a fourth to a half box of fruit to the tree. The crop increases annually at the rate of about a quarter box for oranges and a half box for grapefruit until the trees come into full production about the tenth year. There are exceptional groves which yield 500 boxes per acre or even more of grapefruit or oranges in a single season, but only the very best groves average more than 200 boxes annually. The average yield for Florida, including the best as well as the poorest groves, is about 150 boxes to the acre, or somewhat less than 2 boxes to the tree. There are commercial groves in Florida producing profitable crops at an age of 30 or 40 years.

FIG. 14.—A low flat-wheeled orchard truck for hauling oranges from a Florida grove.

Very heavy plantings of citrus trees have been made in the last 10 years, and many growers fear the danger of overproduction. While it is true that enormous crops of fruit may be harvested in the Gulf States in the near future, it is equally true that the market demand is increasing.

The increasing utilization of off-grade fruit through the newly developed canning process for grapefruit, the bottling of citrus-fruit juices, and preparation of candied fruit, will doubtless have a tendency to absorb the lower grades of fruit, thus steadying the demand for the well-grown attractive product. The development of new markets through better distribution, and the stimulation of consumption through advertising are factors of importance in maintaining a balance between production and consumption.

When all of these factors are taken into consideration it is evident that future profits in citrus culture will require the investor to exert the greatest skill and judgment at every step. Care is particularly essential when the available capital is limited. The man of wealth who invests in a citrus grove more as a winter home or

a hobby than as a business has only to select a pleasing home site, of which there are very many in the Gulf States; in his case profits are of minor importance. On the other hand the man who must depend upon the returns from his grove for a living must exercise the greatest caution in selecting his grove and the greatest skill and energy in its development. The risk from frost, as well as the more common sources of loss, must be taken into consideration.

Before purchasing citrus lands or groves the investor should make a personal visit to the locality and carefully study the situation. It is rarely advisable to buy land or to develop a grove unless the owner can give the property his personal attention. It is much safer for the beginner to start in citrus growing on a small scale and expand after learning the business than to plunge heavily at the start.

The prospective purchaser can secure much valuable information by consulting successful growers, and it is an excellent plan to hire out for a season or two with some experienced grower before purchasing land or planting a grove. The United States Department of Agriculture and the State agricultural experiment stations will gladly supply information when requested.

PUBLICATIONS ON CITRUS FRUITS.

PUBLICATIONS AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT OF AGRICULTURE.

Control of the Citrus Thrips in California and Arizona. (Farmers' Bulletin 674.)
Handling and Shipping Citrus Fruits in the Gulf States. (Farmers' Bulletin 696.)
Citrus-Fruit Improvement: How to Secure and Use Tree-Performance Records. (Farmers' Bulletin 794.)
Spraying for the Control of Insects and Mites Attacking Citrus Trees in Florida. (Farmers' Bulletin 933.)
Frost and the Prevention of Damage by It. (Farmers' Bulletin 1096.)
Control of the Common Mealybug on Citrus in California. (Farmers' Bulletin 1309.)
Citrus-Fruit Improvement: A Study of Bud Variation in the Washington Navel Orange. (Department Bulletin 623.)
The Composition of California Lemons. (Department Bulletin 993.)
Natural Control of the Citrus Mealybug in Florida. (Department Bulletin 1117.)
Citrus Scab: Its Cause and Control. (Department Bulletin 1118.)
Commercial Control of Citrus Scab. (Department Circular 215.)
By-Products from Citrus Fruits. (Department Circular 232.)
Commercial Control of Citrus Melanose. (Department Circular 259.)
Cooperative Improvement of Citrus Varieties. (Yearbook Separate 813.)

PUBLICATIONS FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Culture, Fertilization, and Frost Protection of Citrus Groves in the Gulf States. (Farmers' Bulletin 542.) Price, 5 cents.
Fumigation of Citrus Trees. (Farmers' Bulletin 923.) Price, 5 cents.
Control of the Argentine Ant in Orange Groves. (Farmers' Bulletin 928.) Price, 5 cents.
Factors Governing the Successful Shipment of Oranges from Florida. (Department Bulletin 63.) Price, 20 cents.
Citrus Fruit Insects in Mediterranean Countries. (Department Bulletin 134.) Price, 15 cents.
Katydids Injurious to Oranges in California. (Department Bulletin 256.) Price, 10 cents.

The Production of Sweet-Orange Oil and a New Machine for Peeling Citrus Fruits. (Department Bulletin 399.) Price, 5 cents.
The Navel Orange of Bahia; with Notes on Some Little-Known Brazilian Fruits. (Department Bulletin 445.) Price, 20 cents.
Irrigation in Florida. (Department Bulletin 462.) Price, 15 cents.
A Humidifier for Lemon Curing Rooms. (Department Bulletin 494.) Price, 5 cents.
Citrus-Fruit Improvement: A Study of Bud Variation in the Valencia Orange. (Department Bulletin 624.) Price, 25 cents.
Some Reasons for Spraying to Control Insect and Mite Enemies of Citrus Trees in Florida. (Department Bulletin 645.) Price, 5 cents.
The Argentine Ant in Relation to Citrus Groves. (Department Bulletin 647.) Price 15 cents.
Citrus-Fruit Improvement: A Study of Bud Variation in the Marsh Grapefruit. (Department Bulletin 697.) Price, 20 cents.
Citrus-Fruit Improvement: A Study of Bud Variation in the Eureka Lemon. (Department Bulletin 813.) Price, 25 cents.
Citrus-Fruit Improvement: A Study of Bud Variation in the Lisbon Lemon. (Department Bulletin 815.) Price, 25 cents.
Frost Protection in Lemon Orchards. (Department Bulletin 821.) Price, 10 cents.
Fumigation of Citrus Plants with Hydrocyanic Acid: Conditions Influencing Injury. (Department Bulletin 907.) Price, 15 cents.
Tear-Stain of Citrus Fruits. (Department Bulletin 924.) Price, 5 cents.
The Decay of Oranges While in Transit from California. (Bureau of Plant Industry Bulletin 123.) Price, 20 cents.
A Knot of Citrus Trees Caused by Sphaeropsis tumefaciens. (Bureau of Plant Industry Bulletin 247.) Price, 15 cents.
Some Factors Affecting the Keeping Qualities of American Lemons. (Bureau of Plant Industry Circular 26.) Price, 5 cents.
The Limitation of the Satsuma Orange to Trifoliate-Orange Stock. (Bureau of Plant Industry Circular 46.) Price, 5 cents.
The Woolly White Fly: A New Enemy of the Florida Orange. (Bureau of Entomology Bulletin 64, Part VIII.) Price, 5 cents.
Fumigation for the Citrus White Fly as Adapted to Florida Conditions. (Bureau of Entomology Bulletin 76.) Price, 15 cents.
White Flies Injurious to Citrus in Florida. (Bureau of Entomology Bulletin 92.) Price, 25 cents.
Natural Control of White Flies in Florida. (Bureau of Entomology Bulletin 102.) Price, 20 cents.
Preparations for Winter Fumigation for the Citrus White Fly. (Bureau of Entomology Circular 111.) Price, 5 cents.
Spraying for White Flies in Florida. (Bureau of Entomology Circular 168.) Price, 5 cents.
Insects Injurious to Citrus Fruits and Methods for Combating Them. (Porto Rico Exp. Sta. Bulletin 10.) English and Spanish editions, each 10 cents.
Citrus Fertilization Experiments in Porto Rico. (Porto Rico Experiment Station Bulletin 18.) Price, 10 cents.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

Secretary of Agriculture	HENRY C. WALLACE.
Assistant Secretary	C. W. PUGSLEY.
Director of Scientific Work	E. D. BALL.
Director of Regulatory Work	
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Agricultural Economics	HENRY C. TAYLOR, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	W. B. GREELEY, *Chief.*
Bureau of Chemistry	WALTER G. CAMPBELL, *Acting Chief.*
Bureau of Soils	MILTON WHITNEY, *Chief.*
Bureau of Entomology	L. O. HOWARD, *Chief.*
Bureau of Biological Survey	E. W. NELSON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Fixed Nitrogen Research Laboratory	F. G. COTTRELL, *Director.*
Division of Accounts and Disbursements	A. ZAPPONE, *Chief.*
Division of Publications	EDWIN C. POWELL, *Acting Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
States Relations Service	A. C. TRUE, *Director.*
Federal Horticultural Board	C. L. MARLATT, *Chairman.*
Insecticide and Fungicide Board	J. K. HAYWOOD, *Chairman.*
Packers and Stockyards Administration *Grain Future Trading Act Administration*	CHESTER MORRILL, *Assistant to the Secretary.*
Office of the Solicitor	R. W. WILLIAMS, *Solicitor.*

This bulletin is a contribution from

Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Horticultural and Pomological Investigations	L. C. CORBETT, *Horticulturist in Charge.*

12

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY

PURCHASER AGREES NOT TO RESELL OR DISTRIBUTE THIS COPY FOR PROFIT.—PUB. RES. 57, APPROVED MAY 11, 1922

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1923